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12 SOLAR WIND HELIUM, NEON AND ARGON RELEASED BY OXIDATION OF METAL GRAINS FROM THE WESTON CHONDRITE. R. H. Becker[1], R. S. Rajan[2] and E. R. Rambaldi[2], [1]School of Physics and Astronomy, University of Minnesota, Minneapolis, MN 55455; [2]Space Science Div., 183-501, Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA 91109.

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We have carried out a set of experiments to test the feasibility of determining unfractionated elemental and isotopic ratios for the noble gases in the presumably ancient solar wind present in the gas-rich meteorites. The difficulty with most previous measurements on solar wind noble gases, including much of the work on lunar materials, is that they have been done on silicates, which are susceptible to diffusive gas losses. We have attempted to avoid the problems of diffusive loss by analyzing metal rather than silicates. It has previously been demonstrated that noble gases, at least those of spallogenic origin, do not readily diffuse in meteoritic metal, and to the extent that they do diffuse they are not fractionated (1). It has also been shown that the metal phase of gas-rich meteorites contains less-fractionated gases than the silicates in the same meteorites (2). Since combustion experiments carried out on iron meteorites for the purpose of releasing nitrogen (3) have shown that spallogenic noble gases (and, in the case of Washington County (4), trapped noble gases) are released in a quantitative and apparently unfractionated way from metal when it is oxidized, it seemed to us that combustion of metal from gas-rich meteorites might be a useable technique for extracting solar wind noble gases unaltered and uncontaminated by other noble gas components --a situation not previously attained for Kr and Xe except in the exterior of a lunar ilmenite separate (5). By limiting the available oxygen, the depth of combustion can be controlled. This minimizes the release of spallogenic gases, the only other noble gas component expected in the metal.

The optimum experiment would involve combustion of a pure metal separate. In order to avoid chemical, and even harsh physical, treatment of our sample, which might have affected the surfaces of metal grains, we devised a means of analyzing the metal in the presence of residual silicate not removed by gentle crushing and magnetic separation. Our preliminary results, given in the table below, were obtained by taking advantage of the differing properties of metal and silicates with regard to diffusion. We established on a silicate separate that after an initial 300°C pyrolysis step, a further 300°C pyrolysis produced amounts of He and Ne lower by a factor of 7 than the initial step. We also found that a 250°C pyrolysis following a 300°C pyrolysis yielded a reduction of two orders of magnitude in gas release from the silicates. It is assumed, although not yet proven, that at 300°C essentially no gas is lost from the metal in the absence of oxygen. We therefore carried out two experiments on a grain-size separate of metal from the gas-rich Weston H-group chondrite, involving an initial 300°C pyrolysis followed by either a 250°C combustion or a 300°C combustion in a limited amount of oxygen. In the case of the 300°C combustion, a repeat pyrolysis at 300°C established the contribution of the silicates to the combustion step. In the case of the 250°C combustion, a 250°C pyrolysis followed the 300°C pyrolysis and preceeded the combustion, establishing the silicate "blank" contribution. Because the 250°C combustion appeared to be incomplete, it was repeated with more oxygen, and then followed by another pyrolysis step. All heating steps were 45 minutes long. The presence of radiogenic ^{40}Ar in the silicates, which was released along with solar gases, provided us with a check on the constancy of the diffusive release from the silicates between combustion steps and the pyrolytic steps which served as blanks.

The results of the combustion step at 250°C indicate that the amounts of O_2 used may have been insufficient to completely oxidize the solar-wind-containing zone in the metal. One gets the impression that the gases have been implanted

at depths corresponding to their energies and have not been completely mixed since that time, since it appears that one can etch inward and preferentially remove first the He and then the Ne. The high $^{20}Ne/^{22}Ne$ ratio would in this view be due to the oxidation front not penetrating to the maximum implantation depth of ^{22}Ne. The low amounts of Ar obtained in the 250°C steps (not shown in the table, because the "blank" correction made them very imprecise) support this view, since the Ar would be more deeply sited. The main point of this experiment, however, is demonstrated by the results of the 300°C experiment. The O_2 to metal ratio was higher, so oxidation would have penetrated more deeply, helped by the higher temperature as well. The measured He:Ne:Ar ratios, as well as the $^4He/^3He$ and, to a slightly lesser extent, the $^{20}Ne/^{22}Ne$ ratios, are all in excellent agreement with the results for the metal phase of Pantar (2), and with the present-day solar wind Ne:Ar and $^{20}Ne/^{22}Ne$ ratios obtained by the Apollo Solar Wind Composition experiment (6). This in spite of the fact that the correction for the silicate contribution in the 300°C combustion step amounted to about 30% of the total gases released.

The results of this experiment suggest that, with some modifications in the choice of pyrolysis and combustion temperatures and in the amount of O_2 used, it should be possible, by oxidizing the surfaces of metal grains from gas-rich meteorites, to obtain data on solar wind that has not been fractionated by diffusive loss. Measurements on Kr and Xe should be attainable simply by scaling up the amount of metal used, and there should be very little chance of mixing of other Kr and Xe components into the metal-sited solar wind gases because of the low contents of noble gases in metals in general. The one potential problem that might occur is the possible presence of combustible phases, other than the metal, which may be noble gas carriers. Obviously, the best solution would be a clean metal separate, but the above technique provides a feasible experimental approach even in the absence of a pure separate.

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	T (°C)	ΔO_2 (mtorr-ℓ)	$\frac{^4He}{^{20}Ne}$	$\frac{^{20}Ne}{^{36}Ar}$	$\frac{^4He}{^3He}$	$\frac{^{20}Ne}{^{22}Ne}$	$\frac{^{21}Ne}{^{22}Ne}$	$\frac{^{36}Ar}{^{38}Ar}$
*Weston #1 (23.8 mg)	250	9.2	1040 ±70	-	2340 ± 20	15.4 ±.3	0.0360 ±.0008	-
	250	4.8	808 ±54	-	2260 ± 25	14.6 ±.2	0.0353 ±.0008	-
	250	-	714 ±61	-	2270 ± 60	15.1 ±.5	0.0347 ±.0013	-
*Weston #2 (15.2 mg)	300	11.4	794 ±53	47.2 ± 4.0	2310 ± 20	13.4 ±.1	0.0353 ±.0003	5.43 ±.07
Pantar Metal (2)	-	-	745	-	2200	13.8	0.0383	-
SWC (6)	-	-	570 ±80	45. ±11.	2350 ±120	13.7 ±.3	0.0323 ±.0042	-

* grain diameter range: $63\mu < d \leq 1000\mu$